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TITLE	Balance Truer (clock & watch) 6-72.205; Balance Wheel and Impulse Pin Sub-Assembler (clock & watch) 8-72.10; Final Inspector, Balance Wheel (clock & watch) 6-72.234; Hairspring Solderer (clock & watch) 8-72.10; Hairspring Vibrator (clock & watch) 6-72.135; Inspector, Watch Parts (clock & watch) 6-72.215; Put in Beat Adjuster (clock & watch) 6-72.224; (Balance Wheel Assembly Department)--Technical Report on Standardization of the General Aptitude Test Battery.
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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is also included. (AG)

ED 062414

TECHNICAL REPORT

ON

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

FOR

BALANCE TRUER (clock & watch) 6-72.205
BALANCE WHEEL AND IMPULSE PIN SUB-ASSEMBLER (clock & watch) 8-72.10
FINAL INSPECTOR, BALANCE WHEEL (clock & watch) 6-72.234
HAIRSPRING SOLDERER (clock & watch) 8-72.10
HAIRSPRING VIBRATOR (clock & watch) 6-72.135
INSPECTOR, WATCH PARTS (clock & watch) 6-72.215
PUT-IN-BEAT ADJUSTER (clock & watch) 6-72.224

(BALANCE WHEEL ASSEMBLY DEPARTMENT)

B-414
or
S-150

ED 062414

U. S. Employment Service in
Cooperation with
the
Texas State Employment Service

U. S. DEPARTMENT OF LABOR
Bureau of Employment Security
Washington 25, D. C.
February 1959

GATB #2215
February 1958

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY FOR WATCH ASSEMBLY OCCUPATIONS IN THE BALANCE WHEEL ASSEMBLY DEPARTMENT

B-414 or S- 150

Summary

The General Aptitude Test Battery, B-1002A, was administered to a sample of 59 women employed in the Balance Wheel Assembly Department at the U.S. Time Company, Abilene, Texas. The occupations covered in the Balance Wheel Assembly Department are as follows:

Balance Truer 6-72.205
Balance Wheel and Impulse Pin Sub-Assembler 8-72.10
Final Inspector, Balance Wheel 6-72.234
Hairspring Solderer 8-72.10
Hairspring Vibrator 6-72.135
Inspector, Watch Parts 6-72.215
Put-In-Beat Adjuster 6-72.224

The criterion consisted of broad category supervisory ratings. On the basis of mean scores, correlations with the criterion, job analysis data, and their combined selective efficiency, Aptitudes K-Motor Coordination, F-Finger Dexterity, and M-Manual Dexterity were selected for inclusion in the test norms.

GATB Norms for Watch Assembly Occupations in the Balance Wheel Assembly Department - B-414 or S-150

Table I shows, for B-1001 and B-1002, the minimum acceptable score for each aptitude included in the test norms for Watch Assembly Occupations in the Balance Wheel Assembly Department.

TABLE I

Minimum Acceptable Scores on B-1001 and B-1002 for B-414 or S-150

B-1001			B-1002		
Aptitude	Tests	Minimum Acceptable Aptitude Score	Aptitude	Tests	Minimum Acceptable Aptitude Score
S	CB-1-F CB-1-H	95	S	Part 3	90
F	CB-1-O CB-1-P	90	F	Part 11 Part 12	85
M	CB-1-M CB-1-N	90	M	Part 9 Part 10	85

Effectiveness of Norms

The data in Table IV indicate that 15 of the 20 poor workers, or 75 percent of them, did not achieve the minimum scores established as cutting scores on the recommended test norms. This shows that 75 percent of the poor workers would not have been hired if the recommended test norms had been used in the selection process. Moreover, 34 of the 39 workers who made qualifying test scores, or 87 percent, were good workers.

TECHNICAL REPORT

I. Problem

This study was conducted to determine the best combination of aptitudes and minimum scores to be used as norms on the General Aptitude Test Battery for Watch Assembly Occupations in the Balance Wheel Assembly Department.

II. Sample

The General Aptitude Test Battery, B-1002A, was administered during the period December 10, 1957 to February 10, 1958 to a sample of 59 women employed in the Balance Wheel Assembly Department, U. S. Time Company, Abilene, Texas. These workers were shifted about in the entire Balance Wheel Assembly Department. All the workers had completed an on-the-job training program.

Table II shows the means, standard deviations, ranges, and Pearson product-moment correlations (corrected for broad categories) with the criterion for age, education, and experience.

TABLE II

Means (M), Standard Deviations (σ), Ranges, and Pearson Product-Moment Correlations (Corrected for Broad Categories) with the Criterion (σ^r) for Age, Education, and Experience

Watch Assembly Occupations in the Balance Wheel Assembly Department
N = 59

	M	σ	Range	σ^r
Age (years)	28.6	7.2	19-47	-.278
Education (years)	10.7	1.5	6-12	.104
Experience (months)	21.7	21.7	2-82	-.019

There are no significant correlations between age, education, or experience and the criterion. The data in Table II indicate that the sample is suitable for test development purposes with respect to age, education, and experience.

III. Job Descriptions

Job Titles: Balance Truer 6-72.205
Balance Wheel and Impulse Pin Sub-Assembler 8-72.10
Final Inspector, Balance Wheel 6-72.234
Hairspring Solderer 8-72.10
Hairspring Vibrator 6-72.135
Inspector, Watch Parts 6-72.215
Put-in-Beat Adjuster 6-72.224

BALANCE TRUER
Job Summary: Operates a lathe-like machine which indicates by rotation of the balance wheel and staff assembly the trueness of the wheel and staff.

Work Performed: Closes switch to start motor of machine. Stops the rotation of the belt driven chuck by holding finger against plastic rim of chuck. Picks up balance wheel assembly from plastic tray with tweezers. Moves tail piece to the sight to allow balance wheel and staff to be placed in chuck by depressing foot pedal. Places large end of balance staff into chuck and releases foot pedal which allows tail piece to move against other end of balance staff through truing staff to its even axis. Lifts finger from plastic rim of chuck allowing balance wheel and staff to rotate with dial indicator rod against side of balance wheel (allowance of plus or minus .00016" from the perpendicular to the axis of the staff). Balance wheel in the chuck is stopped and bent perpendicular to the staff axis by moving a small lever which forces a die against the rim of the balance wheel. Starts balance wheel and observes movement of dial indicator, repeating straightening sequence if necessary. Depresses foot pedal, moving tail piece away from balance staff allowing completed assembly to drop into plastic tray.

BALANCE WHEEL AND IMPULSE PIN SUB-ASSEMBLER
Job Summary: Drives impulse pin into balance wheel using a foot actuated press.

Work Performed: Places a quantity of impulse pins into divided tray at the front of press. Places a quantity of balance wheels into other portion of tray. Picks up impulse pin with tweezers and places it in positioning hole in center of fixture. Picks up balance wheel and places it into fixture between aligning posts so that hole in balance wheel is in line with impulse pin. Moves foot pedal which closes press driving pin into wheel. Releases foot pedal which opens press. Removes balance wheel and impulse pin assembly with tweezers and drops into plastic tray at front of press.

FINAL INSPECTOR, BALANCE WHEEL
Job Summary: Using a microscope, visually inspects balance wheel assemblies as the final step in the balance wheel department.

Work Performed: Using tweezers, lifts balance wheel from tray which contains cleaned assemblies. Places wheel assemblies under microscope and inspects for any defects such as distorted spring, spring off beat, damaged points, damaged impulse pin, or bent wheel. Removes wheel assembly with tweezers and places it in a compartmented tray in accordance with findings of inspection.

HAIRSPRING SOLDERER
Job Summary: Solders hairspring to hub using a time soldering device and working with a microscope.

Work Performed: Places a pre-counted number of hairsprings and hubs in plastic tray adjacent to fixture. (All work is performed under a microscope.) Picks up one hub with hub pick and places it in recess in center of fixture

with slot and shoulder up. Uses tweezers to pick up one hairspring and lays it on fixture so that straight section of spring is parallel to and against shoulder of hub. Depresses foot switch which heats hairspring and hub on the fixture so that solder will stick. Swings hinged soldering head over fixture holding hairspring and hub. Depresses lever on soldering head momentarily to place drop of solder on joint of spring and hub to fasten them together. Releases solder head which automatically swings aside to its original position, Depresses air valve foot pedal which allows a cool blast of air to flow over the soldered joint to "Set" the solder, while picking up next hub from tray. Releases air valve when solder loses its silvery color, denoting cooled state. Ejects finished piece by pressing lever at side of fixture.

HAIRSPRING VIBRATOR
Job Summary: Operates a machine which automatically vibrates and indicates at what proper length to cut the hairspring.

Work Performed: Observes all work performed through magnifying glass attached to machine. Picks balance wheel and hairspring assembly from tray with tweezers and lays it on plastic pad with hairspring side up. Picks assembly up with tweezers by the tail end of the hairspring. Moves the assembly into machine so that end of balance staff rests in a concave jewel. Opens, with left hand, jaws of a holding device, which will take up or let out the hairspring in order for the proper length to be determined. Places the hairspring tail end between the jaws, with balance staff in the concave jewel, and releases the opening lever thus closing the jaws. Slides cover of compartment to point to start air blowing on wheel; observes wheel actions until oscillation of wheel reaches "360° in nest; slides cover to close compartment. Loads other side of machine. Observes indicator wheel which will stop turning when hairspring length has been determined. Depresses cutting lever to sever the hairspring at desired length when indicator stops moving. Lifts completed piece from machine with tweezers and places it in a plastic board which keeps each pin separated.

INSPECTOR, WATCH PARTS
Job Summary: Using a microscope, visually inspects the points of the balance staff and the impulse pin in the balance wheel.

Work Performed: Using tweezers, picks up from a plastic tray a balance wheel and staff assembly. Moves assembly under microscope to inspect for bent or burred points of pin. Rotates balance wheel with finger of other hand to visually check for damage. Drops damaged assembly in plastic box at right. Drops passed assembly into plastic tray at left side of microscope.

PUT-IN-BEAT ADJUSTER
Job Summary: Using an open and set block, a boat stick, and opening tweezers, opens and sets the hairspring so that the end of hairspring coincides with impulse pin of balance wheel.

Work Performed: Performs all phases of adjustment with the aid of a jeweler's loupe. Using tweezers, picks up a balance wheel and hairspring assembly. Places it in fixture so that hairspring is above the dividing plate and the balance wheel is below separating plate with the impulse pin in guide slot. Using special tweezers, grips hairspring with varying degrees of pressure to impart a straightening effect so that the hairspring can be fitted to the regulator without distorting the entire spring. Uses loupe to observe all phases of work. When end of hairspring coincides with curvature of guide line scribed on divider plate, picks up beat stick and places it on balance staff and rotates entire hairspring and hub so that end of hairspring coincides with impulse pin of balance wheel.

IV. Experimental Battery

All the tests of the GATB, B-1002A, were administered to the sample group.

V. Criterion

The criterion for this study consisted of broad category supervisory ratings. The balance wheel assembly department foreman and the plant superintendent rated each worker on her ability to perform her duties in the jobs in the Balance Wheel Assembly Department. The rating was a composite, overall evaluation by the foreman and the plant superintendent. The workers were placed in one of three categories, "good," "average," or "poor." This placed 20 workers in the "good" group, 19 in the "average" group, and 20 in the "poor" group. For computational purposes the qualitative ratings were converted to quantitative scores of 61, 50, and 39 for the good, average, and poor groups, respectively.

VI. Statistical and Qualitative Analyses

A. Statistical Analysis:

Table III shows the means, standard deviations, and Pearson product-moment correlations (corrected for broad categories) with the criterion for the aptitudes of the GATB. The means and standard deviations of the aptitudes are comparable to general working population norms with a mean of 100 and a standard deviation of 20.

TABLE III

Means (M), Standard Deviations (σ), and Pearson Product-Moment Correlations (Corrected for Broad Categories) with the Criterion ($_{c}r$) for the Aptitudes of the GATB

Watch Assembly Occupations in the Balance Wheel Assembly Department
N = 59

Aptitudes	M	σ	$_{c}r$
G-Intelligence	94.2	17.5	.242
V-Verbal Aptitude	92.2	14.8	.222
N-Numerical Aptitude	88.7	17.4	.197
S-Spatial Aptitude	103.6#	17.0	.186
P-Form Perception	103.1#	18.9	.344**
Q-Clerical Perception	99.5	16.2	.301*
K-Motor Coordination	101.1	16.9	.284*
F-Finger Dexterity	105.3#	21.4	.635**
M-Manual Dexterity	101.1	18.1	.358**

** Significant at the .01 level
* Significant at the .05 level
# Relatively high mean score

The highest mean scores in descending order of magnitude were obtained for Aptitudes F, S, and P, respectively. All the aptitudes, except Aptitude F have standard deviations of less than 20. Aptitude V has the lowest standard deviation.

For a sample of 59 cases, correlations of .334 and .257 are significant at the .01 level and the .05 level of confidence, respectively. Aptitudes P, F, and M correlate significantly with the criterion at the .01 level. Aptitudes Q and K correlate significantly with the criterion at the .05 level.

B. Qualitative Analysis:

The statistical results were interpreted in the light of the job analysis data. The job analysis indicated that the following aptitudes measured by the GATB appear to be important for these occupations.

Spatial Aptitude (S) and Form Perception (P) - required to properly position impulse pin into balance wheel; to fit hairspring to the regulator without distorting the entire spring; and to place hairspring and hub assemblies in press.

Motor Coordination (K), Finger Dexterity (F), and Manual Dexterity (M) - required to handle and place parts quickly and accurately with tweezers; to use small especially designed tools for making adjustments in assemblies. Also required for arm and hand movements in picking up materials from trays and placing in various types of machines.

C. Selection of Test Norms:

Based on the quantitative and qualitative evidence cited above, Aptitudes S, P, K, F, and M warranted further consideration for inclusion in the test norms. The evidence for each of these aptitudes is indicated below.

Aptitude	Relatively High Mean Score	Significant Correlation with the Criterion	Importance Indicated by Qualitative Analysis
S	X		X
P	X	X	X
K		X	X
F	X	X	X
M		X	X

Although Aptitude Q showed significant correlation with the criterion at the .05 level, it was not considered further for inclusion in the norms because there was no other quantitative or qualitative evidence of significance. Various combinations of Aptitudes S, P, K, F, and M, with appropriate cutting scores were selected as trial norms. The relationship between each set of trial norms and the criterion (dichotomized as indicated in section VII) was determined.

A comparison of the results showed that B-1002 norms consisting of S-90, F-85, and M-85 had the best selective efficiency.

In test development studies an attempt is made to develop a set of norms such that the cutting score for each aptitude included in the norms will be set at a five-point score level close to one standard deviation below the aptitude mean of the experimental sample. Adjustments of cutting scores from one standard deviation below the mean are made to effect better selective efficiency of the norms. In this study the aptitude cutting scores are each within 5 points of one standard deviation below the aptitude mean of the sample.

VII. Concurrent Validity of Norms

For the purpose of computing the tetrachoric correlation coefficient between the test norms and the criterion and applying the Chi Square test, the criterion was dichotomized with those workers rated as Good and Average placed in the high criterion group, and with those rated as Poor placed in the low criterion group. This resulted in 20 of the 59 workers, or 34 percent of the sample, being placed in the low criterion group.

Table IV shows the relationship between test norms consisting of Aptitudes S, F, and M with critical scores of 90, 85, and 85, respectively, and the dichotomized criterion for Watch Assembly Occupations in the Balance Wheel Department. Workers in the high criterion group have been designated as "good" workers and those in the low criterion group as "poor workers."

TABLE IV

Relationship between Test Norms Consisting of Aptitudes S, F, and M with Critical Scores of 90, 85, and 85, Respectively, and the Criterion for Watch Assembly Occupations in the Balance Wheel Assembly Department

N = 59

	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	5	34	39
Poor Workers	15	5	20
Total	20	39	59

$r_{tet} = .84$ $\quad X^2 = 20.121$

$\sigma_{r_{tet}} = .22$ $\quad P/2 < .0005$

The data in the above table indicate a significant relationship between the test norms and the criterion for the sample.

VIII. Conclusions

On the basis of mean scores, correlations with the criterion, job analysis data, and their combined selective efficiency, Aptitudes S, F, and M with minimum scores of 90, 85, and 85, respectively, are recommended as B-1002 norms for Watch Assembly Occupations in the Balance Wheel Assembly Department. The equivalent B-1001 norms consist of S-95, F-90, and M-90.

IX. Determination of Occupational Aptitude Pattern

When the specific test norms for an occupation include three aptitudes, only those occupational aptitude patterns which include the same three aptitudes with cutting scores that are within 10 points of the cutting scores established for the specific norms are considered for that occupation. The only one of the existing 23 occupational aptitude patterns which meets these criteria for this study is OAP-14 which consists of S-80, F-90, and M-85. for B-1002 and S-85, F-95, and M-90 for B-1001. The selective efficiency of OAP-14 for this sample was determined by means of the tetrachoric correlation technique. A tetrachoric correlation of .64 with a standard error of .22 was obtained, which indicates a significant relationship between OAP-14 and the criterion for this experimental sample. The proportion of the sample screened out by OAP-14 was .29, which is within the required range of .10 to .60. Therefore, it is recommended that OAP-14 be used in counseling for Watch Assembly Occupations in the Balance Wheel Assembly Department.